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THESIS – THÈSE

Title of Thesis – Titre de la thèse

Meta memory Strategies: A Study of Learning Disabled and Normally Achieving Adolescents

Degree for which thesis was presented
Grade pour lequel cette thèse fut présentée

M.Ed.

Year this degree conferred
Année d'obtention de ce grade

1985

University – Université

University of Alberta

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Metamemory Strategies: A Study of Learning Disabled and Normally Achieving Adolescents

by

Leith DeTracey

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Education

IN

Special Education

Department of Educational Psychology

EDMONTON, ALBERTA

Fall 1985

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Supervisor

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Date April 29, 1985

DEDICATION

Dedicated to my daughter Jennifer

and

all the other learning disabled children who struggle to remember.

ABSTRACT

The present study examined the relationship between metamemory, strategy use, and performance in a paired associate memory task. One hundred and one grade seven, eight, and nine normal achieving and reading disabled students were asked to study and recall a list of twenty word pair associates. An equal number of high and low frequency words were used. Half of each group viewed each word-pair for 10 seconds while the other half viewed them only long enough to read the words. After recall, each student was asked how they tried to remember the word-pairs. Following this, they were asked which strategy (read carefully, rehearsal, visual elaboration, verbal elaboration) they used for each word-pair. Each answer was recorded and scored. The data was analyzed to compare total recall, use of metamemory for recall performance, and study strategies between the normal achievers and the reading disabled groups.

Knowledge of appropriate memory strategies (metamemory) was positively related to strategy use and recall performance for the normally achieving groups. The reading disabled's recall performance did not show great differences between metamemory knowledge or no metamemory knowledge and as a result they did poorly. For both normal achievers and reading disabled groups no age effects were observed across groups.

Analysis of study strategies suggested that the reading disabled were still using rehearsal as their main strategy and had not really developed an awareness that mnemonics aid recall, while the normal achievers had. The grade 9 reading disabled scores pointed to a gradual development towards awareness of metamemory (elaboration) for studying the pairs compared to the grade 7 and 8 poor readers. High or low frequency word pairs did not influence elaboration for either group in this research. Availability of stimuli during study time showed a trend towards increasing the number of pairs recalled for all groups but did not influence study strategies.

Inadequate metamemory knowledge by reading disabled adolescents demonstrated in this study has educational implications for remedial programming. In order for these students

to become independent learners and meet minimal academic requirements, present remedial programs must be evaluated and improved. Present research suggested that a comprehensive intervention model needs to be developed including an emphasis on helping the learning disabled student discover the most efficient strategy for the task at hand and learn to apply that strategy effectively in a variety of situations.

ACKNOWLEDGEMENTS

The author would like to thank several people for their co-operation and assistance that made the completion of this thesis a reality.

I would particularly like to give special thanks to my supervisor, Dr. R. F. Mulcahy, for his enthusiasm for my topic and his expert guidance throughout this project.

I would also like to thank the other members of my committee, Dr. L. R. Wilgosh and Dr. A. E. Wall, for their support and advice.

Sincere thanks are also due to principals C. Small, H. Haiduk, R. Zapisocki, N. Campbell and W. Loehr for their interest and support, and to all the students that participated in my research.

The computer and typing skills of Judith Abbott were greatly appreciated.

Many thanks to Lyn Griffith for being a good friend.

Lastly, I would like to thank my husband Peter and children Sean, Kara, Jennifer and Brendan for their support and interest in my academic pursuits.

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I. INTRODUCTION

Adolescents in junior high school who read two or more years below grade level are already at an academic disadvantage. At a time when these students are expected to acquire more content knowledge, to remember and integrate it, their limited reading skills further impede school progress. Their prognosis for academic success and completion of high school is poor (Schumaker et al., 1980). Research has indicated that reading disabled students develop more slowly than normal learners in the use of mnemonic strategies (Tarver et al., 1976; Torgesen, 1977; Wong, 1980; Torgesen & Light, 1983). With increased academic expectations, particularly at the junior high level, the application of memory strategies would aid recall of materials for tests as well as the integration of concepts.

Flavell (1971) invented the word "metamemory" to explain an individual's knowledge and awareness of how his/her memory works in various memory situations. A great deal of research has evolved since then (Masur et al., 1973; Kreutzer et al., 1975; Brown, 1975; Salatas & Flavell, 1976; Wellman, 1978; Kurdek & Burt, 1981; Waters, 1982). These studies have demonstrated that metamemory develops with age, emerging spontaneously at adolescence and reaching refinement at adulthood. Memory strategies can be taught to children for improved performance but are not generalized to similar tasks (Salatas & Flavell. 1976; Pressley & Dennis-Rounds. 1980). Only by adolescence does a student apply mnemonic aids without explicit prompts (Rohwer, 1973; Masur et al., 1973; Rohwer et al., 1977; Pressley & Levin, 1977; Pressley & Dennis-Rounds, 1980; Waters, 1982).

Some studies have explored the metamemorial development of reading disabled students (Torgesen, 1979; Wong, 1980; Swanson, 1983; Rose et al., 1983). Torgesen (1979) suggested that the reading disabled behave differently when required to memorize nonmeaningful material. He theorized that many reading disabled children may have difficulty in the "management" of their capacities; they don't actively manipulate and organize material to be learned and as a result are inactive learners. Wong (1980) found that reading disabled students, when prompted, could generate strategies for memory tasks but were less efficient and less

adaptive than normal readers.

Most of the research that has looked at the development of metamemory has dealt with normal populations. Little research has been addressed to metamemory and behaviour on memory tasks of reading disabled adolescents at the junior high level. Since the employment of memory strategies would appear to enhance academic achievement, it is important to find out if reading disabled adolescents have metamemorial skills. If these students are developmentally delayed as the literature suggests, then results of this research could influence the direction of remedial programming at the junior high level, where there presently is little or no clear programming direction.

The purposes of the study presented here, therefore, were to determine:

1. If reading disabled adolescents at the junior high level are aware that appropriate memory strategies aid study.
2. If these reading disabled students use metamemory strategies spontaneously.
3. How the reading disabled students' performance in a paired-associate memory task compares to their normally achieving peers.

II. SELECTIVE REVIEW OF LITERATURE

A. Introduction

Flavell (1971) defined metamemory as the individual's knowledge of and awareness of memory or of anything pertinent to information storage and retrieval. Therefore a person must have the knowledge that some situations require a strategy in order that information can be recalled, must know an appropriate strategy, and must put this strategy to use.

Although studies in metamemory have only come into prominence since the early 1970's, awareness of the necessity for memory strategies goes back to ancient times. In 477 B.C. the poet Simonides identified mangled bodies at a banquet by recalling where each person had been sitting. According to Yates (1966) in her book, *The Art of Memory*, an unknown rhetoric teacher in Rome compiled in 82 B.C. a useful textbook entitled *Ad Herennium*. The memory section of this book was a well known and much used text even in the Middle Ages. The author of *Ad Herennium* discussed a theory of images related to remembering things and words. Mental imagery has continued to be studied and practised up to and including the present time.

The following selective review of the literature will first include a brief overview of recent models of memory, then examine memory from a developmental perspective relating to the emergence of metamemory, as well as the propensity of metamemory in adolescence. The characteristics of learning disabled students and their awareness of metamemory will be addressed in the final section of this review.

B. Models of Memory

A number of recent models for memory have been theorized, applying different conceptual approaches. William James (1890) held a dichotomous view of memory, separating primary and secondary memory. Information held in consciousness and readily available was identified as primary memory whereas information not in consciousness but able to be retrieved

existed in secondary memory. Waugh and Norman (1965) also employed James' primary and secondary memory dichotomy in a more expanded version. They held that information entering primary memory had a limited capacity; it could be maintained by rehearsal or be forgotten. Information rehearsed in the primary memory could then be transferred to and stored in secondary memory which had unlimited capacity (Seamon, 1980, pp. 108-112).

Atkinson and Shiffrin (1968) extended Waugh and Norman's theory even farther, presenting a multi-store framework. Their model represented an information processing point of view analogous to a digital computer with its input and output of information, described as a working memory of limited capacity and a central memory of possibly unlimited capacity (Adams, 1980, p. 236). Atkinson and Shiffrin differentiated between the structural features of memory and attendant control processes. Structural features were considered to be built-in processes that were fixed and invariant while control processes were defined as storage and retrieval operations which were controlled by the subject within a variety of task demands (Naus et al., 1978, p. 220). Information is momentarily registered in the sensory store. From this sensory register, information can be temporarily stored in short term memory. Transfer of this information from short term to long term memory can be achieved by rehearsal which establishes a weak memory trace, or coding, which involves the alteration or the addition of the information to strengthen retention and make retrieval easier. Retrieval of information is dependent upon the subject's control processes of rehearsal and coding of information in long term memory. Long term memory therefore becomes a repository of established knowledge and language (Adams, 1980, p. 236).

Shiffrin (1975) has substantially changed this theory by unifying the three memory stores. Rehearsal and coding are viewed as strategies which serve to direct the flow of information within and among the various structural components of the memory system (Seamon, 1980, p. 111-112). Material held in short term memory gains stability by making contact with associative concepts and images already held in long term memory (Adams, 1980, p. 241).

Craik and Lockhart (1972) deemphasized the structural features of the memory system and defined memory in terms of the processes that are carried out on material to be remembered. Memory here is considered to be a series of processing levels from shallow sensory processing to deeper abstract and semantic levels. The greater the depth of processing, less forgetting will take place. Naus and Halasz (1978) suggested that the "depth of processing" view can deal with the "automatic" aspects of memory processing as well as deliberate processing (Naus et al., 1978).

Bjork (1974) proposed the existence of a central processor which he viewed as a conscious mechanism that directs attention, storage, rehearsal, retrieval and a variety of other mnemonic activities. Hagen et al. (1975) described Mandler's (1974a, 1974b) theory whereby the use of mnemonic devices, storage strategies, and retrieval processes all require the intervention of the conscious system. Ornstein (1978) wrote that there is a strong relationship between memory and other cognitive processes. Memory is viewed as constructive in the sense that it is not the exact copy of experience but rather incoming information is actively interpreted in terms of the existing knowledge base. Hagen et al. (1975) suggested that changes in memory development can be attributed not to changes in structural components but rather to changes in the type of processing done by children.

C. Development of Memory

Vygotsky (1962) stated that:

> reflective awareness and deliberate control come to the fore in the development process. Mechanical memory changes to logical memory guided by meaning and is now deliberately used by the child.(p. 90)

Reese (1976) suggested that there is a general progression in the acquisition of memory strategies during childhood. First the strategy is absent, then it is available but not unless induced and even when induced used inefficiently. Next the strategy is available and when induced can act effectively, and finally a memory strategy is used spontaneously and efficiently

(metamemory). Reese's description is a reiteration of Flavell's terminology of production and mediational deficiencies. A production deficiency is said to exist when the child does not spontaneously produce an appropriate memory strategy but if trained to do so, can use the mnemonic to improve performance. A mediational deficiency exists when the child either spontaneously or after being taught a strategy fails to use it effectively to enhance performance.

Wellman et al. (1975) presented evidence that children as young as three understand the word remember. A toy was hidden and those children who were told "to remember where the dog was" would look at or touch the place where the toy was hidden while the examiner was absent.

The earliest type of memory recall displayed by children is recognition memory (Kail, 1979). Kail described research by Brown and Scott (1971) which indicated that preschool children could recognize long strings of pictures with a high degree of accuracy and retention was reasonably high a week after the initial viewing. Kail (1979) hypothesized from the results of several studies that developmental change for recognition memory tasks was small if the role of strategy was minimized. However, when stimuli are more complicated the child must scan a picture more effectively in order to remember and, under this condition, a developmental change is more likely.

Haith (1971), in a short-term memory recognition experiment using visual geometric stimuli, compared five year olds' performances with that of adults. The children's memory for one symbol on a viewing was accurately reported but dropped by 60% when multiple items were shown on the same card. On the other hand, adults reported an increasing number of items as the number of presented items increased. Haith suggested that a reasonable interpretation for this superiority of adults in multiple stimuli memory tasks was due to their ability to visually rehearse the encoded information. Kail (1979) suggested that older children and adults have more skill in recognition memory due to more effective scanning and an increase in the ability to find meaningful relationships among objects in pictures to aid recall.

Rehearsal is the first memory strategy that a child actively engages in. Flavell (1970) described his research with Beach and Chinsky (1966). Children aged five, seven, and ten, were shown seven pictures to be recalled. Experimenters, trained as lip readers, noted whether the children overtly rehearsed the names of the pictures. The children were also asked how they tried to remember the stimuli. Rehearsal, both reported and observed, was minimal for the five year olds (10%), but was observed for 80% of the seven year olds and 100% of the ten year olds.

In a follow-up experiment, discussed by Flavell (1970), Keeney, Cannizzo and Flavell (1967) divided six year olds into two groups as observed to be verbal rehearsers or non-rehearsers. The rehearsers were further divided into experimental and control groups. The experimental groups were taught and given practise with verbal rehearsal. When trials were administered, there was essentially no difference in the performance of the two experimental and the control groups. There was a marked improvement for the non-rehearsers that had been taught to rehearse. On a final trial, 60% of the experimental non-rehearsers abandoned the rehearsal strategy as they had been taught, whereas the experimental and control rehearser groups all continued rehearsal as a memory strategy. This research indicated that, for some six year olds, there was a lack of awareness that rehearsal was a useful memory strategy. Although they were taught and used the strategy effectively when instructed, there was no carry over and, therefore, the children would be described as having a production deficiency.

Hagen et al. (1973) trained five and seven year olds to rehearse. They found rehearsal facilitated recall at both age levels. However, on a post-test, the improved recall due to induced rehearsal was found to disappear and there was no transfer effect for induced rehearsal a week later.

The studies represented showed that rehearsal strategies can be taught but that training will have little impact on a younger child using this memory aid spontaneously.

Categorizing appears to be the next strategy that develops to aid memory. Kail (1979) stated that only as children grow older do they become increasingly more flexible in their

rehearsal; modifying it as necessary to meet the demands of a particular memory task. Kail (1979) described Ornstein, Naus and Liberty's (1975) study using eight, ten, and thirteen year old subjects who were presented randomly twenty words for recall; the words belonged to four familiar categories and all of the children were informed of these categories. They found that thirteen year olds rehearsed the members of a category together, whereas the eight year olds never did and the ten year olds did so only rarely. The younger children did not realize the benefit of rehearsing category members together.

Kail and Hagan (1977) discussed Kobasigawa's (1975) study conducted with six, eight, and eleven year old children. Twenty-four pictures representing eight categories were shown to the children. Each category was represented with a picture, e.g., zoo. During presentation, the relationship with category clue was explicitly indicated. For the recall task, the subjects were given the category pictures to be used if they thought these cards would be helpful. The six year olds who used the cue cards recalled only one item from each category. The eight year olds randomly used the cue cards several times and recalled 66% of the test items. The eleven year olds recalled 80% of the items, using the cue cards to recall all items in one category before moving to the next.

Neimark, Slotnick and Ulrich (1971) tested students in grades 1, 3, 4, 5, 6, and college on their recall of twenty-four words from pictures. The pictures could be categorized into four classes but were set out in random order. Subjects were allowed three minutes to study the cards and were told that they could move the cards around in any order and make notes if they wished. Recall improved across age with the college students being superior. Neimark et al. suggested that for a memory task to be successful, there had to be two requirements: 1) an exhaustive organization system produced and 2) knowledge of what had been already recalled and what was yet to come. They found that the young children seemed unaware of both requirements and often scanned the cards saying they were ready well before the 3 minute study interval. The older children were more aware of structuring the pictures into categories but only used these classifications to recall missing items. The college students deliberately organized

their study and recall of the cards. Partial or exhaustive alphabetizing within categories was only observed at college level.

D. Emergence of Metamemory

A person must have knowledge or an awareness of memory phenomena for it to be termed metamemory (Flavell, 1971). Flavell and Wellman (1977) proposed that a person's awareness of memory could include an awareness of:

- different memory tasks;
- different memory strategies to be used depending on the task;
- the relationship between personal differences and differing memory performance;
- how task, strategy, and person variables interact in memory situations.

Hagen et al. (1975) stated that if a child does not view himself as an active memorizer, then he is unlikely to initiate spontaneously the deployment of strategies in various memory tasks. Developmentally it has been shown that children become more and more able to act in an intelligent, planful, task-adaptive manner in an ever increasing array of memory tasks (Brown, 1975; Flavell, 1970).

As noted from the review of literature to this point, three year olds did understand that they must remember but not until age seven did children actively rehearse and not until age eleven did they recognize that they could use a strategy such as categorization to help them with recall. Brown and DeLoache (1978) suggested that a child's passivity in many memory and problem solving tasks may be a direct result of a lack of experience on such a task. Kail (1979) wrote that as children grow older, they acquire more knowledge about their world and this acquisition has a profound effect on their effort to remember. Thus the match between information to be remembered and a child's cognitive structure appears to be critical for memory. Brown (1975) stated that the mature memorizer adopts skills or strategies which increasingly involve attempts to make material more meaningful and therefore more manageable. Flavell and Wellman (1977) suggested that, as memory develops, the term

"retrieval" is more applicable than "recall" as it implies that we use an internal as well as an external search of accumulated knowledge to remember things or information.

Several studies have used a question format to survey children's growing awareness of mnemonic aids, and their understanding of individual capacities and limitations, for future retrieval situations. The most notable study is by Kreutzer, Leonard and Flavell (1975), who interviewed children representing kindergarten and grades 1, 3, and 5. Fourteen questions were designed to test the children's awareness of memory phenomena such as forgetting, relearning, immediate delay, remembering details, study time, and planning. Kreutzer et al. found that the younger children (kindergarten and grade 1) generally appeared to understand fairly well the meaning of "learn", "remember", "forget" and other common mnemonic expressions. However, the older children (grades 3 and 5) seemed to know the same things better and had more awareness that memory ability varies over occasions, types of data, and individuals. The older ones also recognized that the experiences of learners can affect future recall. This study suggested that metamemory starts emerging in middle childhood. Hagen's (1975) critique in Kreutzer et al. (1975) stated that although this study illustrates the growing awareness of memory abilities, one cannot conclude that a child's understanding of memory strategies would necessarily correlate with his/her performance in tasks requiring mnemonic strategies.

Kurdek and Burt (1981) adapted some of the Kreutzer et al. (1975) questions for their own research examining the developmental trends in and the relationships between metacommunicative, metamemorial and metasocial cognitive skills of children in grades 1 through 6. Their findings in the metamemory area were similar to those of Kreutzer et al. in that the older children recognized the importance of systematic mnemonic strategies and were more aware of retroactive interference and memory decay.

Wellman (1978) tested five and ten year olds on their understanding of how memory variables in interaction affect memory performance. After being trained in the correct techniques, the subjects were given nine different memory judgment tasks in the form of placing three pictures in descending order from most difficult to easiest. The tasks involved

judgment of memory for relevant simple/relevant complex and irrelevant simple/irrelevant complex. There was no significant difference for five or ten year olds for relevant simple items but the ten year olds were more accurate on the complex relevant items with five year olds being substantially inferior. The five year olds judged these problems only on the basis of one relevant variable, which supported the view of Flavell and Wellman (1977) that children proceed from a lack of understanding of memory relevant phenomena to the acquisition of an array of certain separate facts and later develop a more complex interactive system of memory knowledge.

Flavell, Friedrichs, and Hoyt (1970) studied developmental changes in the memorization processes with nursery, kindergarten, 2nd and 4th grade children. The purpose was to see if a child could predict his own immediate memory span and to observe if he realized how long he had to study before he could achieve perfect recall. Flavell et al. found that at each grade level the mean predicted span was higher than actual span but the differences between the two spans was sharply reduced for the two oldest groups. There was also a very marked improvement over this age range in the child's ability to sense when he had memorized a set of items sufficiently well to recall them perfectly. Results from this data indicated no relationship between object span prediction and knowledge that a subject has of his own memory processes, although both reflected developmental changes across age.

Salatas and Flavell (1976) taught kindergarten, grade 3 and college students to recall lists correctly within set categories. They then tested retrieval of the words in categories with a different context (e.g., things that break) and an anti-clustering task. The kindergarten children did not understand the concept of using categories for recall so they were eliminated leaving a comparison of the 3rd graders and college students. At first the children did not use the category search algorithm and had difficulty doing so even when explicitly instructed. Later they did not use category search spontaneously but were capable of doing so if asked. This illustrates a classical production deficiency pattern. The college students were much more likely to use a category search in answering questions and were also explicit in describing how they

had used it, which showed their awareness of using memory strategies for retrieval of information. Salatas and Flavell (1976) stated that this study indicated developmental trends in the ability to use and control the structural organization of information for recall. This parallels real life demands when students are required to co-ordinate information that they have learned in situations such as writing an examination.

Masur, McIntyre, and Flavell (1973) investigated how grades 1, 3 and college students studied for a free recall test over five trials. Subjects were allowed to choose half of the pictures presented for recall for further study. Subjects were interviewed at the end as to how they studied and why they chose particular cards. The grade 1 students were inarticulate about their choices for study, mentioning "hard" or "easy" items. In marked contrast all but two grade 3 students verbalized that they chose missed or new items. The college students also mentioned missed items but also spoke of making associations with the more difficult items to remember. This study provided evidence that young children come to a learning task lacking memory strategies that are spontaneously produced by adults.

E. Metamemory during Adolescence

By the end of elementary school, normal children have an awareness of their memory capacity, and have started to develop an array of metamemorial knowledge (Kreutzer et al., 1975; Kurdek and Burt, 1981; Neimark et al., 1971). Lodico et al. (1983) suggested that, in general, strategies used by older children are more complex than those used by younger children. Studies by Salatas and Flavell (1976) and Masur et al. (1973) showed that by college age, students have highly developed mnemonic skills that they employ spontaneously. The propensity for metamemory would therefore appear to still develop over the adolescent years.

One of the most common ways for studying memory strategies has been paired associate learning tasks. The subject is presented with a series of word pairs to be remembered. The first word of each pair acts as the stimulus in that it functions as a retrieval cue for the recall of the second word. The ease of learning word paired associates depends on the subject's

ability to generate a verbal or visual (imagery) elaboration to relate the words within the pair. This task therefore is an excellent one for the study of basic learning and memory processes. Paired associate learning tasks have also been a major method in exploring the development of metamemory during adolescence. Rohwer (1973) found evidence that the relative effects of various types of prompts are not the same for adolescents and younger subjects. From his study with children aged four to eleven in paired-associate tasks Rohwer concluded that during childhood, minimal prompts are not sufficient to activate elaboration in a systematic or reliable manner. Rohwer (1973) found that there was a pronounced shift in the relative effect of minimal prompt from the end of the childhood period (grade 6) to the end of the adolescent period. For the grade 11 students, the minimal prompt condition was at least as effective as the explicit or augmented condition for promoting elaboration. Therefore Rohwer contended that in adolescence the principal locus of the shift appears to be in a growing sufficiency of minimal prompts for paired associate memory tasks. Rohwer (1973) suggested:

> At the beginning of adolescence, the learner is fully capable of elaborative processing; by the end of the period, he cannot only accomplish elaboration on cue but also regards and uses it as a means for achieving other ends. (p. 44)

Pressley and Dennis-Rounds (1980) used twelve and eighteen year olds in two associative tasks, learning the products of cities and then learning Latin definitions. Subjects were either instructed to use a keyword method to learn city/product pairings or simply told to learn the pairs. Then all subjects were presented with a list of Latin nouns and their translation to learn. Only the eighteen year olds spontaneously transferred the key word strategy to the Latin task. When the twelve year olds that were taught the keyword method for the cities were given the hint "to do something like what you did to learn city and product," they learned more Latin vocabulary than the control group. Pressley and Dennis-Rounds' data supported Rohwer's (1973) proposition that the degree of prompting required to induce elaborative transfer decreases with increasing age during adolescence. It also demonstrated that learning strategies taught to older adolescents can be generalized to other school tasks.

Pressley and Levin (1977) found, from interviewing grade 5, 7 and 9 students, that their performance on a paired-associate memory task related directly to the strategies that each student reported for learning the pairs. The majority of the grade 5 students reported using only rehearsal to learn the pairs while the majority of grades 7 and 9 students reported strategies in addition to or instead of rehearsal. Very few grade 9 subjects relied exclusively on rehearsal and reported using elaboration on most or all of the pairs. However, relatively few grade 9's relied on elaboration to learn the entire list. The few younger subjects who reported elaborating most of the pairs out-performed those older subjects that did not report elaborating the pairs. This study indicated a strong developmental trend towards the knowledge and use of strategies: however, it was clearly shown that the strategy reported was a better predictor of pair-associate learning performance than the age of the subject.

Chi (1981) proposed that:

> the increasing use of strategies may be the result of a complex set of processes involving the acquisition and perfection of the strategies themselves, coupled with the development of content knowledge to which these strategies are to be applied. (p. 226)

She felt that memory strategies are a generalized form of specific procedural knowledge.

Chi (1978) conducted research using children with a firm knowledge of chess and adults with no knowledge for a memory task involving the placement of chess pieces. The children out-performed the adults. The adults were observed more often to apply strategies to help them remember the placement of the chess pieces but overall the adult task-specific strategies, as shown by their poorer performance, did not overcome the children's greater advantage of accumulated knowledge of chess. Chi's (1981) suggestion, that acquisition of content knowledge becomes generalized into memory strategies, supported Rohwer's (1977) theory that the propensity for memory strategies starts developing across the adolescent period. Generally, normal adolescents will acquire more concepts from their more advanced schooling and thus generalize this into more accomplished methods of memory strategies. Chi's results also supported Pressley and Levin's (1977) findings that a few grade 5 students outperformed the

older subjects because of more developed awareness of memory strategies.

Waters (1982) studied the relationship between metamemory, strategy use and performance with grade 8 and 10 students. Students were given a memory task of 24 word pair associates and then interviewed on specific ways that each individual studied each pair; reading, rehearsal, visual or verbal elaboration. There was no explicit prompting before the task. Subjects who knew that elaboration was the best strategy recalled significantly more word pairs and there was a significant main effect for age indicating that the grade 10 students recalled more word pairs than the grade 8's. Students who knew elaboration was best, used it significantly more for studying the pairs but there was no significant main effect or interaction across the grades. This research demonstrated that spontaneous knowledge about elaborative strategies is related to study and performance on a paired associate memory task for adolescents. It also indicated a developmental effect across the grade 8's and 10's.

The literature reviewed in this section has suggested that adolescents do spontaneously incorporate elaboration into their repertoire to meet the demands of solving problems, learning, and memory tasks and that this propensity for metamemory increases with age over adolescence. Since learning disabled adolescents are usually two or more years behind in reading, will they be developmentally delayed as well in their knowledge and use of effective memory strategies? The next section of this literature review will discuss the learning disabled.

F. Learning Disabled Students

Torgesen and Licht (1983) stated that:

> A core concept in the definition of learning disabilities is that these children perform in the average range on measures of general learning ability such as standardized intelligence tests but show particular problems learning school subjects in a manner inconsistent with their ability to assimilate the general information and skills measured on IQ tests. (p. 16)

Maier (1980) suggested that remedial programs for reading disabled students are primarily skill oriented and even after the child has developed decoding skills, comprehension is often superficial and limited to recall of specific facts; the student still lacks the ability to generalize or draw inferences from the passages read. Havertape and Kass (1979) found that most of the reading disabled adolescents in their research read "parts of the problem several times in a rote manner seemingly more from habit than to enhance comprehension." They also observed that some of these reading disabled students skipped over parts of the directions that seemed too difficult for them to comprehend or attempted to solve the problem without reading the directions. Eighty percent of normal subjects comprehended the problem whether they successfully solved it or not. Only forty percent of the learning disabled comprehended what they read but in very few cases did this prevent the student from putting forth an answer or solution. Bos and Filip (1982) described comments, regarding inconsistencies in a reading passage, by a learning disabled student who did not consider it unusual for a passage not to make sense because "the stories I usually read don't make sense." Bos and Filip (1982) quoted Huhn's study (1980) in which he suggested that learning disabled students may be susceptible to comprehension difficulties because they "lack adequate scaffolding or schemata for incorporating new concepts." (p. 82)

Besides reading well below their grade level, Tarver et al. (1976) showed that reading disabled students developed more slowly than normal learners in the use of the active mnemonic strategy of verbal rehearsal, lagging approximately two years behind. Ten year old learning disabled subjects performed as normal eight year olds and twelve to fourteen year old learning disabled like eleven year old normals on a serial position recall task. Torgesen and Licht (1983) suggested that several studies indicate that many learning disabled children are similar to younger or retarded children in the way that they adapt to the processing demands of various tasks.

Several studies have shown that the learning disabled are consistently less active, planful and organized in their approach to memory tasks compared to children the same age

that learn normally. Torgesen and Goldman (1977) replicated the Flavell, Beach, and Chinsky (1966) study using eight year old normal and reading disabled students. They found that the poor readers did not spontaneously use verbal rehearsal as a strategy to the same extent as normal achievers. Analysis of the inquiry section revealed that a greater number of poor readers failed to indicate an awareness of rehearsal as a consciously applied mnemonic strategy.

Torgesen (1977) found that grade 4 reading disabled subjects did not use categorizing to help the recall of words although the categories were mentioned generally and subjects were told they could move the cards in any manner in order to study them. Recall of reading disabled subjects was deficient compared to normal readers. These children were then taught to sort the cards into categories as a mnemonic aid and their recall improved to the extent that there was no significant difference from that of the good readers. Torgesen et al. (1979) used similar procedures as Torgesen (1977). Following the initial test for recall, there were reading and spelling activities for 10 minutes and then another recall of stimulus cards. Two days later the students were taught to stack cards in categories. After a 3 minute sorting period, recall was taken. Delayed recall was assessed after a 10 minute activity similar to the first session. Analysis of the data indicated that the poor readers benefitted more from performing the sorting task than did the good readers. Recall for the reading disabled was much better and they demonstrated improved memory strategies.

These studies provide evidence that study strategies can be taught to the reading disabled for much improved memory performance. This would appear to indicate that the reading disabled have a production deficiency when it comes to an awareness and application of mnemonic aids for memory tasks.

When a child is off task, the processing activities required for learning academic content of that task are negligible. Torgesen (1982) viewed this off task behaviour as inactive learning. His "inactive learner" concept emphasized the frequently passive and disorganized nature of the learning disabled children's approach to learning tasks. Torgesen (1977) felt that the inactive learner lacks cognitive awareness and motivation which results in an inability to

adopt task-appropriate strategies. Owings et al. (1980) concluded that "many students peform below their potential, in part because they do not spontaneously monitor and regulate their learning." (p. 250)

Wong (1980) used two experiments with grades 2 and 6 learning disabled and normal achieving students. The subjects were required to recall sentences either completed with an explicit prompt or without prompts although an implicit prompt could be made for each sentence. In both grades the reading disabled recalled significantly more sentences in the explicit condition than the non-cued condition. Good readers recalled significantly more sentences in the implied consequence cues condition than the learning disabled readers. Wong (1980), in a second experiment with a new group of learning disabled students, examined whether the reading disabled had a production deficiency and could overcome it by directed strategies. Each student was read the sentence as before but this time prompted to add a consequence. The examiner asked several questions until she felt the student had given a satisfactory response. The results of this recall were compared to the learning disabled students in the control condition in the first experiment. The prompt interaction indicated the procedure was equally effective for students in both grades, with a very significant improved recall compared to the non-cued condition. This showed that the learning disabled with a production deficiency can be "activated" to generate processing strategies for successful performance on a given specific task. It also illustrated how learning disabled students take a passive role when it comes to activating a task-appropriate strategy.

Bos and Filip (1984) investigated comprehension monitoring skills of learning disabled and average grade 7 students. Two reading passages, with inconsistencies within them, were used. There were two conditions; cued (where students were asked to look for inconsistencies) or non-cued. Only 15% of the learning disabled subjects noticed a problem in interpretation of the passages compared to 80% of average students in the non-cued condition. Under the cued condition there was no difference between groups. These results supported Torgesen's conceptualization of learning disabled students as inactive learners.

The above studies suggest that learning disabled students have to be constantly prompted to use strategies for memory or learning tasks and have developed a "learned helplessness." Torgesen and Licht (1983) suggested that this stems from their experiences in school, conditioned by chronic failure. Some children come to school unprepared to assume the new role of "self-conscious learner" and thus perform below the level predicted from their ability to learn at the preschool level. These children fall rapidly behind in the initial basic skills that are important foundations for future learning and quickly lose confidence in their own ability. These experiences of failure can often lead to attitudes of the learning disabled child that s/he has insufficient ability and that success is attributed to "external" factors such as ease of task, teacher's help, or luck (Licht, 1983).

Over long periods of time and across a wide variety of school tasks, this "helplessness" belief sets in and learning disabled children display a maladaptive pattern of achievement related behaviours (Licht, 1983). By the time learning disabled students have reached adolescence, some acquire defensive strategies that are strongly ingrained and these students are even less motivated to try and succeed (Deschler et al., 1984). The assumption is that learning disabled adolescents generally have a poor self-concept because they cannot help but feel less competent than their normal achieving peers (Silverman and Zigmond, 1983).

Silverman and Zigmond (1983) administered the Piers-Harris Children's Self-Concept Scale to 159 learning disabled students in grades 6 to 12. Although there were some students with very low self-concept scores, the data indicated that learning disabled adolescents did not have lowered self-concepts as compared to the norms of the Piers-Harris Scale. The authors proposed that students, when answering the questions, may have selectively used multi reference groups. Academically they compared themselves with other learning disabled students in the resource room setting and made social comparisons relevant to their peers in regular classes. However, if a learning disabled child was only in the regular school system with no remedial support, the results of such a survey might not agree with Silverman and Zigmond's report.

Silverman and Zigmond (1983) suggested that by adolescence, many learning disabled students have managed to compensate for their school deficiencies by finding successful ego enhancing experiences outside the academic realm. Success in extracurricular activites may diminish the impact of school failure. This could also lead to the learning disabled adolescent's passive attitude towards academic endeavours at which he firmly believes that he will never succeed. At this stage in his/her life peer social acceptance would seem of greater importance.

In summary, the literature reviewed in this section revealed that learning disabled children are developmentally lagging in memory and learning strategies compared to their normal achieving peers. These children also appeared to be "inactive" learners having developed a "learned helplessness" attitude, compounded by years of frustration and lack of achievement.

G. Metamemory and the Learning Disabled

Results from studies in the previous section indicated that learning disabled children had production deficiencies but could be prompted to apply task appropriate strategies which greatly improved their performance. The question arises as to whether the learning disabled have acquired metamemory knowledge and use it spontaneously. There have been few studies that have investigated metamemory with learning disabled subjects.

Torgesen (1979) used several slightly revised questions from Kreutzer, Leonard and Flavell (1975) to study age nine normal and reading disabled children's understanding of memory strategies. Results showed no significant difference between the two groups for the first four questions involving memory ability, savings, immediate delay, and a choice of opposite or arbitrary type pairs for a memory task. However, differences in productive thinking and strategies were significant for the last three questions which demonstrated metamemory knowledge. The reading disabled students had fewer and poorer answers to solve memory problems and showed a lack of planfulness. Torgesen (1979) suggested that the reading disabled experience difficulty in the "management" of their capacities.

Swanson (1983) used eight and ten year old non-disabled and learning disabled to study the relationship among metamemory, rehearsal activity and word recall. The students were presented orally a list of seven words for recall, and told to practise out loud. A second list of seven words along with instructions to repeat each word was orally presented. A third instruction with a new list was given to practise each word with the others earlier presented in the current list. The children were shown the final list and asked to estimate how many they could remember. Following the final recall test there was an interview to see how the children went about remembering the words. Swanson's results indicated that the older children were better at estimating task difficulties when presented with specific rehearsal procedures. The younger students did not realize the advantage of following instructions. The learning disabled's span estimate did not influence their overall performance (recall score). Although they used rehearsal activities as instructed, they were less able to articulate their plan for remembering the words.

Rose et al. (1983) demonstrated that elementary school age reading disabled children could be taught to use verbal rehearsal and visual imagery to aid reading comprehension recall. The students' recall performance in the unaided condition was significantly poorer. This study supported the contention that learning disabled children have reading comprehension difficulties due to inefficient memorization strategies but can be taught mnemonic strategies to aid recall of reading passages.

The above three studies indicated that learning disabled children have a developmental delay in metamemory knowledge and demonstrated little if any spontaneous use of mnemonic aids to enhance performance.

H. Summary

This review of literature has shown that the acquisition of memory strategies develops with age. Children generally begin to rehearse at age seven and start categorizing at age eleven. Memory strategies can be taught to a child for improved recall but are not generalized to similar

tasks unless the child is prompted to do so. Awareness that a task requires a strategy and application of an appropriate memory strategy (metamemory) appears to emerge spontaneously during adolescence and reaches refinement at adulthood. Paired associate learning tasks have been one method of exploring how subjects spontaneously relate the words in each pair by visual or verbal elaboration, in order to aid recall. Studies have indicated that learning disabled students may be developmentally delayed in memory and metamemory strategies, performing more like retarded or younger children. Research has also shown that the learning disabled rely on more primary strategies such as rehearsal and must be taught more advanced ones such as categorization, context prompts, or elaboration. It would appear that these students have a production deficiency for memory strategies and constantly need to be prompted to apply appropriate strategies. There is however an obvious lack of research examining memory and metamemory strategies of learning disabled adolescents. The purpose of this study, therefore, is to attempt to determine the types of memory and metamemory strategies learning disabled adolescents use in a paired associate memory task.

III. RATIONALE, HYPOTHESES, AND DEFINITIONS

A. Rationale for Study

There has been a great deal of research that has explored memory development and the emergence of metamemory with normal children. The few studies cited in the last section of this literature review investigated metamemory with learning disabled subjects of elementary school age. This author found only one reference to research that addressed metamemory and behaviour on memory tasks of reading disabled adolescents at the junior high level. How learning disabled adolescents understand and use memory strategies could relate to their academic achievement and future success in the regular high school system. A word paired associate memory task will be used which allows for the study of metamemorial processes. Results will evaluate whether a subject is aware that a memory strategy is required, and if s/he has the knowledge that a visual or verbal elaboration, relating the words in each pair, will aid recall performance.

This study will therefore examine the relationship between metamemory, strategy use, and performance comparing groups of reading disabled and normally achieving adolescents in grades 7, 8 and 9. Results from this research could have implications for academic programming and the direction of remedial instruction for learning disabled students in junior high school.

B. Hypotheses

1. The reading disabled students will recall fewer word pairs compared to the normal achievers.
2. The reading disabled students will demonstrate less awareness of metamemory strategies (visual or verbal elaboration) in recall and studying the word pairs compared to the normal achievers.

3. The older reading disabled students (grade 9) should use more metamemory as study strategies and therefore have a better recall performance than the younger reading disabled students (grade 7).

These hypotheses were evaluated by analysing the recall performance on a word pair associate memory task and the results from an interview with each subject which discussed how each word pair was studied.

C. Definitions

Within the context of this study the following definitions will be used:

Metamemory (meta): The awareness that visual or verbal elaboration, to relate the words within each pair, will aid recall. The use of visual or verbal elaboration to study word pairs.

No metamemory (no meta): No awareness or use of visual or verbal elaboration.

Elaboration: To create a visual image or make up a verbal phrase or sentence to relate the words within each pair.

Normal Achievers (N) were defined as:

1. having an IQ of 89 or above on the Otis-Lennon School Ability Test or the Canadian Lorge-Thorndike Intelligence Test;
2. reading at or above grade level on the Gates-McGinitie Reading Tests, Form E, Canadian Edition, comprehension and vocabulary sections.

Reading Disabled (RD) were defined as:

1. an IQ score of 89 or above on the above mentioned group intelligence tests;
2. English as a first language;
3. no known severe behavioural problems;
4. reading at one and one half years or more below grade level on the Gates-MacGinitie Reading Test, Form E - Comprehension Section.

IV. METHOD

A. Subjects

A total of 101 students participated in this study. This included 54 normal achievers and 47 reading disabled (see definitions in Chapter 3). They were recruited from two junior high schools at CFB Edmonton and three junior high schools in the Edmonton Catholic School System. Parental permission was granted.

Nine subjects were dropped from the sample because they did not meet the criteria. The breakdown of reasons for removal was:

- 4 students - IQ scores were too low
- 1 student - IQ score incomplete
- 2 students - English was not their first language
- 1 student - influenced by sister previously tested
- 1 student - did not understand directions completely.

Two subjects (1 grade 7 and 1 grade 9, both reading disabled) were removed to obtain equal n's within each grade. These students were left out of the analyses because they had the lowest IQ score of 89. The final 90 subjects used for this research were divided into groups as follows:

16 normal achievers - grade 7

18 normal achievers - grade 8

18 normal achievers - grade 9

10 reading disabled - grade 7

14 reading disabled - grade 8

14 reading disabled - grade 9

B. Tests

Testing took place from June to December 1984.

Achievement. The Gates-MacGinitie Reading Test Form E, vocabulary and comprehension was chosen as the instrument to determine reading level because:

1. the same test is applicable to grades 7, 8 and 9;
2. it has Canadian norms;
3. it has grade equivalent norms for three different times of the school year;
4. it has good reliability and validity.

Salvia and Ysseldyke (1981) reported that test-retest reliability based on correlations between pupils' performance in October and May ranged from .77 to .89. Validity reported as correlations with corresponding subtests of the Metropolitan Achievement Test for grade 8, 8 months was .86 (Vocabulary), .80 (Comprehension), and .88 (Total). Gates-McGinitie Reading Tests, Form E, were administered by the experimenter just prior to the paired associate memory task in order to have the students' reading level meet the criteria for that particular time of year.

Ability. The Otis-Lennon School Ability Test and the Canadian Lorge-Thorndike Intelligence Test were the group intelligence tests used by the schools and scores were available to determine the intellectual ability of each student. Sample descriptions are presented in Table 1.

C. Materials

A list was made up of 20 paired-associates (see Appendix 1). The list had 10 pairs of high-frequency concrete nouns, e.g. animal-star, ocean-machine, and 10 pairs of low-frequency concrete nouns, e.g. necktie-bluejay. The nouns were paired so as to minimize associate relatedness. Twenty pairs were chosen in order to provide enough trials for reasonable reliability but not to make the task too ominous. Nouns were randomly selected from two grade four spellers, Third Canadian Edition *Basic Goals in Spelling*, and *The Canadian Spelling*

TABLE 1

SAMPLE DESCRIPTION

			Reading Level Range	
			Vocabulary	Comprehension
N7	$\bar{X}$ IQ	117.19	3 mos. below gr. 7 to five years above gr. 7	3 mos. below gr. 7 to 5 years above gr. 7
	SD	8.23		
	Range	100-132		
N8	$\bar{X}$ IQ	121.94	3 mos. below gr. 8 to 4 yr. 5 mos. above	2 mos. to 3 yr. 6 mos. above gr. 8
	SD	9.49		
	Range	107-137		
N9	$\bar{X}$ IQ	120.67	4 mos. below gr. 9 to 3 yr. 5 mos. + above	1 mos. to 3 yr. 6 mos. above gr. 9
	SD	11.27		
	Range	100-145		
RD7	$\bar{X}$ IQ	103.30	5 mos. above gr. 7 to 3 yr. below gr. 7	2 to 4 yrs. 4 mos. below gr. 7
	SD	6.51		
	Range	89-114		
RD8	$\bar{X}$ IQ	100.71	7 mos. to 2 yrs. 6 mos. below gr. 8	1 yr. 6 mos. to 5 yr. 4 mos. below gr. 8
	SD	5.48		
	Range	91-109		
RD9	$\bar{X}$ IQ	97.71	1 yr. 2 mos. to 5 yr. 4 mos. below gr. 9	2 yr. 3 mos. to 6 yr. 4 mos. below gr. 9
	SD	6.86		
	Range	90-116		

N7 = Normal grade 7
N8 = Normal grade 8
N9 = Normal grade 9

RD7 = Reading Disabled grade 7
RD8 = Reading Disabled grade 8
RD9 = Reading Disabled grade 9

Age Range for grades 7, 8, 9:
Normal Achievers 12.0 to 16.0 years.
Reading Disabled 11.1 to 16.0 years.

Program and checked for frequency in the Thorndike-Lorge, *The Teacher's Word Book of 30,000 Words*. Nouns at this level were chosen as it was presumed that reading disabled students would be able to recognize and read these word-pairs with ease. Words were not tested ahead of time with the poor readers as it was thought it might influence the memory task. In a pilot study involving 20 normal achievers and 8 reading disabled grades 7 and 9 students, the word cupboard with the silent "p" proved to cause reading difficulties, so the pair was changed to read eyebrow-hockey. The rest of the words were all easily recognized by the pilot groups.

D. Procedure

Subjects were tested individually in a quiet room in each school. Each student was told that the study was investigating how junior high students try to remember things. It was mentioned that some people remember better than others but would the student try her/his best. The student was instructed that twenty word-pairs were going to be presented one at a time; after the whole presentation the first member of each pair would be orally presented and s/he would be asked to recall the word that went with it. They were also told that they would be asked how they learned each pair. A word-pair was shown every 10 seconds as Rohwer's (1973) study had suggested that a minimal prompt will effectively activate elaboration provided the presentation is at least 10 seconds. Each student read the word-pair orally. Half the subjects in each group continued viewing the word-pair for the remaining part of the 10 seconds. The other half in each group were told to think about the pair after reading it but were not allowed to view the words during the remaining time. The test of recall was self-paced in that there was no time imposed for response. The student gave an answer or replied that s/he didn't know.

After recall of all pairs the student was asked what strategies s/he used most to help her/him remember the word-pairs. The student was then told that generally four strategies are most commonly used:

a. the student simply reads carefully,

b. the student says the words over and over again (rehearsal),

c. the student generates an image relating the objects referred to in each pair of words (visual elaboration),

d. the student connects the pair of words with a verbal phrase or sentence (verbal elaboration).

This was the reverse order of questioning that Waters (1982) used for her research to study metamemory strategies with junior high students. For the present study it was decided that mentioning the four strategies first might influence a subject's answer to the question as to how s/he tried to remember. By presenting the question first, the student's answer was completely spontaneous. Most of the students usually mentioned one or more of the common strategies. Each pair was then reviewed and the student was asked to identify which of the four strategies s/he used for each. All answers (recall and strategies) were recorded on a prepared form (see Appendix 1). The order of word-pairs was randomized in a predetermined manner for each student. The time of the total task for each subject was approximately 15 minutes.

The pilot study indicated earlier, using the same procedure, had proved to be an appropriate method for studying students' awareness of metamemory and strategy use.

V. RESULTS

The purpose of this study was to relate metamemory, strategy use and performance, comparing normally achieving and reading disabled students at the junior high level. Reading word pairs only once at presentation time and rehearsal were considered non-elaborative, showing no awareness of metamemory, and therefore were less likely to aid memory performance. Visual or verbal elaboration demonstrated knowledge of metamemory and the importance of using these strategies in order to improve performance. The major dependent variables were memory performance judged by word-pairs correctly recalled and study strategies reported as being used for each word pair. Word pairs correctly recalled were recorded and these pairs were then divided into the strategy used for recall; meta (used visual or verbal elaboration) or no meta (read or rehearsed), as described by the subject. The method for studying each pair as stated by each student was also scored for the number of pairs studied using correct metamemory knowledge or no knowledge. The total number of word pairs recalled was calculated out of 20 for each subject; this recall score was then divided according to number of meta/no meta strategies used. The study strategy for each pair was scored and categorized into one of the four strategies mentioned above. Each pair studied was given a score of 1 and the total for the four study categories equalled 20.

Percentages were calculated for the number of students in each group that spontaneously mentioned using metamemory knowledge (visual or verbal elaboration) and are shown in Table 2.

TABLE 2

Knowledge of metamemory spontaneously mentioned

taken as percentage of group

	grade 7	grade 8	grade 9
Norm	*(n=16)*	*(n=18)*	*(n=18)*
	75	61	61
R.D.	*(n=10)*	*(n=14)*	*(n=14)*
	30	29	43

It can be noted that the reading disabled compared to the normal achievers were deficient in spontaneously thinking that the use of elaboration would aid memory recall. A greater proportion of reading disabled grade 9's indicated more awareness of metamemory than the reading disabled grades 7 and 8's in that more of them spontaneously mentioned using elaboration as a strategy to remember pairs.

Table 3 presents the proportion of students using metamemory after they were asked which of the four strategies they used to study each word pair.

TABLE 3

Knowledge of metamemory for study as percentage of group

	grade 7	grade 8	grade 9
Norm	*(n=16)*	*(n=18)*	*(n=18)*
	88	77	94
R.D.	*(n=10)*	*(n=14)*	*(n=14)*
	40	43	78

Overall, regardless of grade, a very large proportion of the normal achievers showed an awareness of metamemory as they generally mentioned that they used elaboration for studying at least some of the word pairs. The reading disabled grades 7 and 8's once again indicated a lack of awareness that a visual or verbal mnemonic would aid performance compared to their normal achieving peers, as shown by their percentage scores of 43 or lower. All but three grade 9 reading disabled students mentioned that they studied some of the pairs by elaborating and used elaboration for study as frequently as the normal achieving grade 8's, (78 percent). This was almost twice the number of the reading disabled grades 7 and 8's, indicating a definite developmental trend towards awareness of metamemory for this older group.

A number of analyses of variance were conducted. For ease of presentation all results of these ANOVA's are provided in Appendix B.

Four 2 x 3 analyses of variance for unequal n's were calculated for Normal Achievers/Reading Disabled x grades 7/8/9. The first analysed the number of word pairs recalled using metamemory (elaboration visual or verbal). There was a highly significant main effect for group (F ratio = 21.968, $p < .001$). There was no main effect or interaction for grade for all four analyses of variance. There was also a highly significant main effect for group for the number of pairs studied using metamemory (elaboration), (F ratio = 12.210, $p < .001$). The 2 x 3 analysis of variance, utilizing the dependent variables of memory

performance and study strategies, indicated that the normal achievers have significantly more awareness of the need for memory strategies and demonstrated better skills in elaboration as shown by their much higher recall on the paired associate memory task and by their study patterns (see Figure 1). No significant difference was obtained for failing to use metamemory strategies for recall. However, there was a highly significant main effect for number of pairs not elaborated (no metamemory) as a study strategy, (F ratio 12.210, $p < .001$). This supports the contention that the reading disabled group evidenced a developmental lag in the awareness of using metamemory for studying compared to their normal achieving peers (see Figure 1).

A further breakdown of the knowledge of elaboration for study is illustrated by Table 4. It can be seen that the normal achievers elaborated about the same number of pairs as those studied without elaboration. The reading disabled, on the other hand, elaborated a minimal number of pairs for study compared to their unelaborated pairs. Once again the reading disabled grade 9's showed more awareness of metamemory (elaboration) for study than did the reading disabled grades 7 and 8.

To compare normal achievers and reading disabled recall using metamemory or no metamemory strategies for recall, a 2 x 2 analysis of variance with equal n's was done for Normal Achievers/Reading Disabled x metamemory/no metamemory. Fourteen normal achieving subjects were randomly withdrawn to produce equal numbers in each group. A significant interaction was evident (F ratio = 9.28, $p < .003$). This interaction is visually depicted in Figure 2. The reading disabled students recalled about the same number of pairs using metamemory or no metamemory strategies. This demonstrated their lack of metamemory which resulted in poor recall. On the other hand, normal achievers have developed metamemory strategies which appears to have produced far better recall compared to no metamemory behaviour.

The mean number of pairs recalled were similar within groups. The normal achievers with a mean number of 8.7 for pairs recalled were considerably higher than the reading disabled with a mean number of 3.7 for pairs recalled. Table 5 shows more specifically the mean number

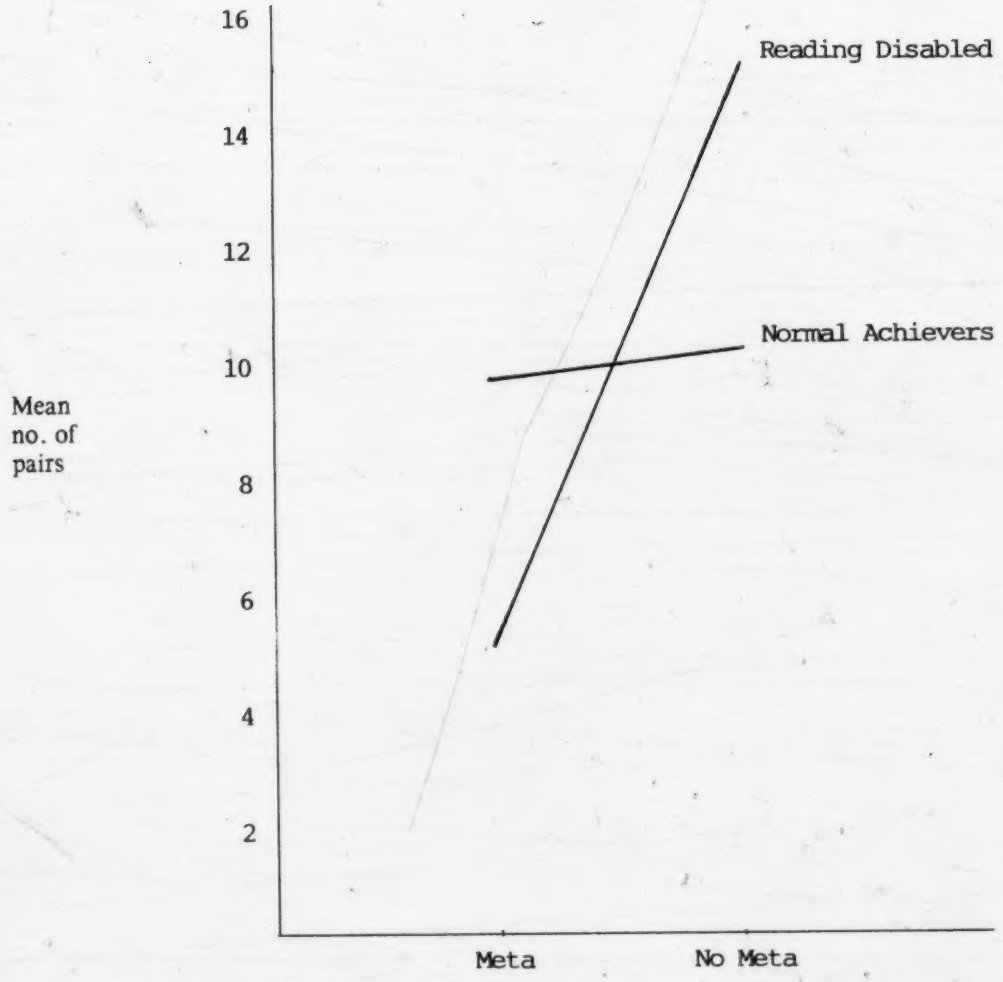

Figure 1.

Mean number of word pairs studied using metamemory or no metamemory.

TABLE 4

Knowledge of Metamemory or no Knowledge
Mean Number of Word Pairs Studied

	Mean Pairs Studied	
	meta	no meta
grade 7 normal achievers	10.6 (S.D. = 6.4)	9.4 (S.D. = 6.4)
grade 8 normal achievers	9.6 (S.D. = 7.52)	10.4 (S.D. = 7.52)
grade 9 normal achievers	9.1 (S.D. = 6.51)	10.9 (S.D. = 6.51)
grade 7 reading disabled	2.9 (S.D. = 4.16)	17.1 (S.D. = 4.16)
grade 8 reading disabled	4.2 (S.D. = 6.66)	15.8 (S.D. = 6.66)
grade 9 reading disabled	6.8 (S.D. = 5.03)	13.2 (S.D. = 5.03)

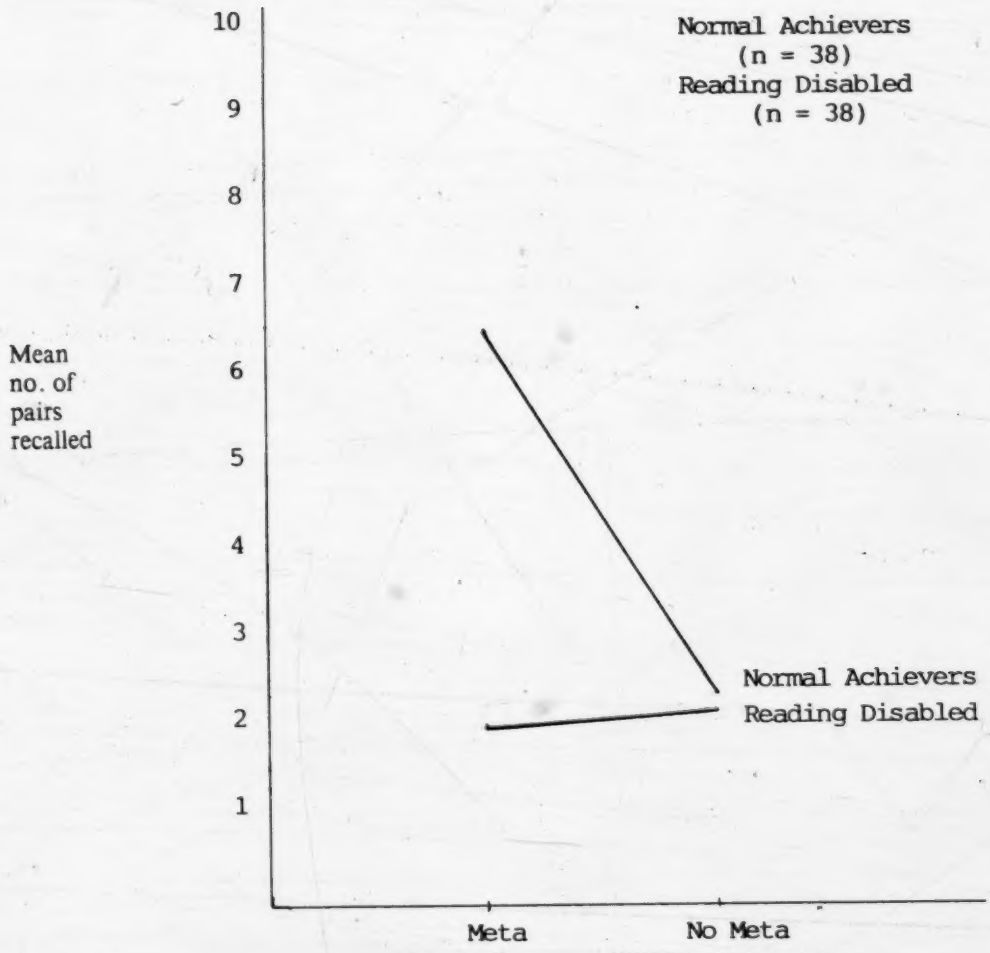

Figure 2.

Mean number of word pairs recalled using metamemory knowledge or no metamemory knowledge.

TABLE 5

Knowledge of Metamemory or No Knowledge
Mean Number of Word Pairs Recalled

	Mean Pairs Recalled	
	meta	no meta
grade 7 normal achievers	5.4 (S.D. = 4.79)	1.5 (S.D. = 1.46)
grade 8 normal achievers	7.5 (S.D. = 6.67)	2.1 (S.D. = 2.77)
grade 9 normal achievers	6.9 (S.D. = 5.89)	2.67 (S.D. = 2.71)
grade 7 reading disabled	1.1 (S.D. = 2.39)	1.9 (S.D. = 1.51)
grade 8 reading disabled	1.9 (S.D. = 3.38)	1.9 (S.D. = 1.36)
grade 9 reading disabled	2.1 (S.D. = 2.53)	1.9 (S.D. = 1.28)

of pairs recorded for all groups with a breakdown using metamemory or no metamemory for recall performance. The similar low means for no metamemory for all groups indicated that non-elaborative study methods did not help recall. The reading disabled groups showed about equal recall using metamemory or no metamemory which indicated their weakness of metamemory knowledge for aiding recall in a paired associated memory task.

There was a discrepancy in the range of IQ scores between the normal achievers and the reading disabled. In order to check for effects of intelligence, IQ was blocked for each group into high and low by a median split (see Table 6).

TABLE 6

IQ Blocked for Groups

	High IQ range	Low IQ range
Norm	120 - 145	100 - 118
	(n=26)	*(n=26)*
	$\bar{X}$ = 128.03	$\bar{X}$ = 112.03
R.D.	102 - 116	89 - 101
	(n=19)	*(n=19)*
	$\bar{X}$ = 105.84	$\bar{X}$ = 94.73

It can be noted that the range of IQ scores for the lower normal achievers was similar to that of the high IQ range for the reading disabled students but that the mean was 6 points lower for the reading disabled. To check whether intelligence was a factor for awareness and use of metamemory, five 2 x 2 analyses of variance for unequal n's were calculated for Normal Achievers/Reading Disabled x High/Low IQ. Highly significant main effect for group

(normal/reading disabled) was indicated for:

1. number of pairs recalled, (F ratio = 26.230, p. < .001);

	High IQ	Low IQ
Normal Achievers	$\bar{X}$ = 8.346	9.154
Reading Disabled	$\bar{X}$ = 3.211	4.105

2. number of pairs recalled using metamemory, (F ratio = 21.323, p. < .001);

	High IQ	Low IQ
Normal Achievers	$\bar{X}$ = 6.423	6.885
Reading Disabled	$\bar{X}$ = 1.579	1.947

3. number of pairs studied using metamemory, (F ratio = 12.275, p. < .001);

	High IQ	Low IQ
Normal Achievers	$\bar{X}$ = 9.423	9.962
Reading Disabled	$\bar{X}$ = 5.053	4.579

4. number of pairs studied using no metamemory, (F ratio = 12.275, p < .001).

	High IQ	Low IQ
Normal Achievers	$\bar{X}$ = 10.577	10.038
Reading Disabled	$\bar{X}$ = 14.947	15.421

The results indicated no main effect for intelligence and no interaction. These results were very similar to the results of the four preceding 2 x 3 analysis of variance which confirms that the reading disabled students lack the awareness of metamemory compared to their normal achieving peers, but that the discrepancies in IQ scores between the two groups had no effect on the results of this research.

The above analysis of data has shown that the reading disabled in this study are deficient in their awareness and use of metamemory to aid performance. Tarver et al. (1976) indicated that poor readers lagged two years behind normal subjects in their use of rehearsal strategies. To check whether the reading disabled subjects in this research were still at the

rehearsal stage in their memory development compared to their normal achieving peers, a 2 x 3 analysis of variance for unequal n's was calculated for Normal Achievers/Reading Disabled x grades 7/8/9 for reading and rehearsal strategies used to study the word pairs. A significant difference was indicated for group on the number of pairs studied using rehearsal, (F ratio = 10.164, p. < .002). Figure 3 illustrates that the reading disabled make extensive use of rehearsal as a study strategy compared to the normal achievers. Also noted in Figure 3 is the reading disabled grade 9's drop off of rehearsal as a strategy which approaches the level of the normal achievers. These results suggested that the reading disabled are still at the rehearsal stage of memory development, and lag considerably behind their normal achieving peers, in their awareness that elaboration strategies would aid recall. There was no significant difference for reading pairs as a mnemonic strategy and no interaction for group and reading or rehearsal of pairs.

Waters (1982) suggested that the availability of materials could improve recall performance because elaboration was more likely to be used as a study strategy, if stimuli could be viewed for a period of study. She found that availability of materials during study time improved recall performance, ($F = 9.67$, $p < .005$), across all ages. Since there was no grade effect in this study, the data was collapsed across grades to produce two groups, normal achievers and reading disabled. To see if the availability of word pairs for study was related to metamemory knowledge, application and performance, four 2 x 2 analysis of variance for unequal n's were calculated for Normal Achievers/Reading Disabled x Availability of Material. Once again results showed a highly significant main effect for groups for:

1. number of pairs recalled using metamemory, (F ratio = 22.151, $p < .001$),

	Available	Not Available
Normal Achievers	$\bar{X} = 7.923$	5.385
Reading Disabled	$\bar{X} = 2.316$	1.211

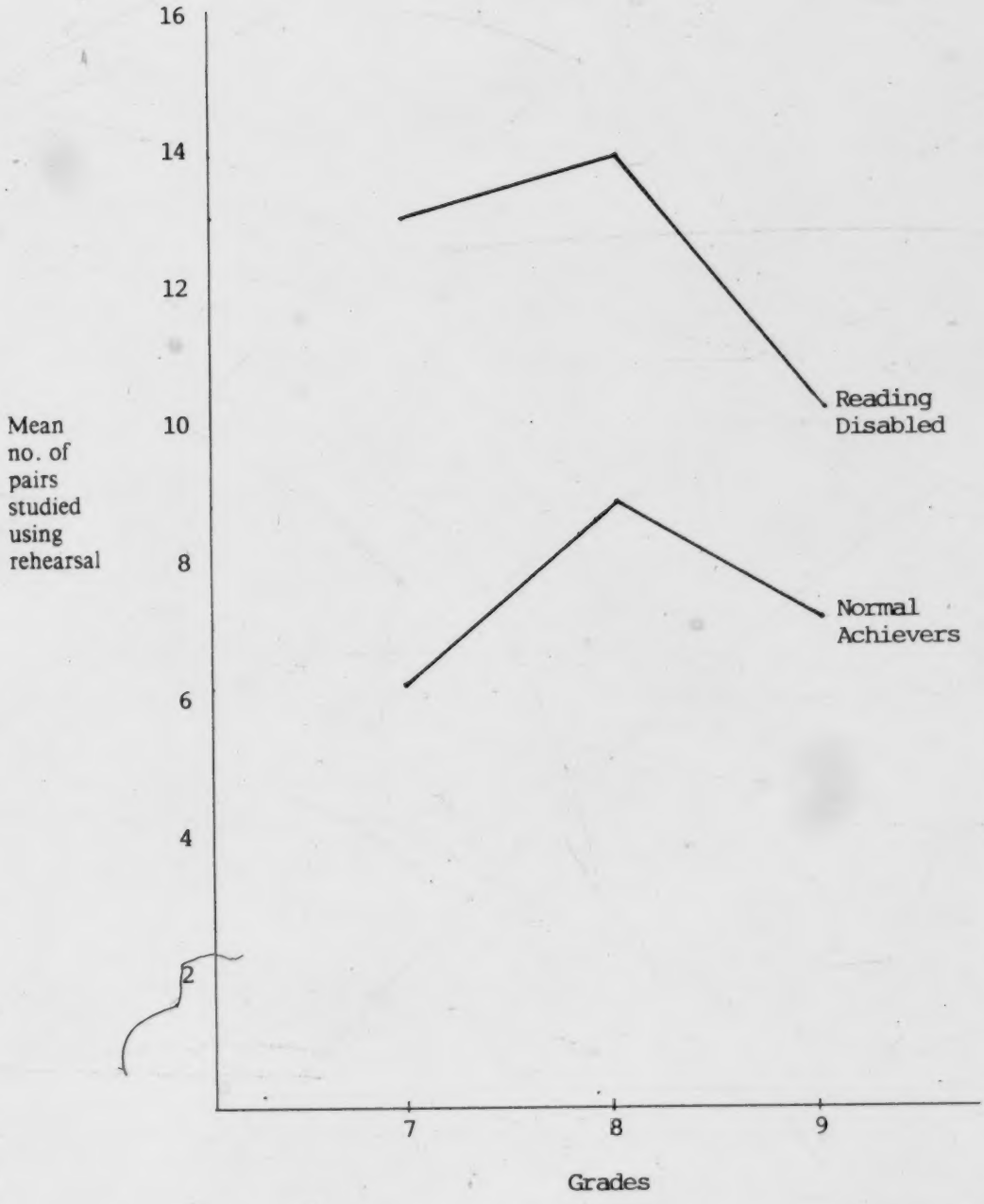

Figure 3.

Mean number of word pairs studied using rehearsal.

2. number of pairs studied using metamemory, (F ratio = 12.349, $p < .001$).

	Available	Not Available
Normal Achievers	$\bar{X} = 10.192$	9.192
Reading Disabled	$\bar{X} = 5.316$	4.316

3. number of pairs studied using no metamemory, (F ratio = 12.349, $p < .001$).

	Available	Not Available
Normal Achievers	$\bar{X} = 9.808$	10.808
Reading Disabled	$\bar{X} = 14.684$	15.684

The results show no main effect for availability of materials either for study or recall. There was, however, a slight trend towards availability effect for recall with respect to metamemory (elaboration) ($F = 3.547$, $p < .063$). This indicated that the availability of viewing each pair during the whole study period rather than just thinking about the words, could affect both groups in their awareness of the use of metamemory for improved performance in a paired associate memory task; this effect is in the same direction as predicted by Waters' theory. However, availability of material in this research did not influence study strategies for either group. As in all previous analyses, the reading disabled students' performance was deficient compared to the normal achievers.

Waters (1982) also found that high frequency words influenced better recall, ($F = 35.64$, $p < .001$). No differences were evident for the mean number of word pairs recalled between high and low frequency words for normal or reading disabled subjects (see Appendix C for table of means). Further analysis of this data was determined to be unnecessary as the means were almost identical. The word pairs used in this research, whether of high or low frequency, did not appear to influence an improved performance.

VI. DISCUSSION AND IMPLICATIONS

The results clearly supported the hypotheses. Reading disabled adolescents in junior high school were deficient in metamemory strategies compared to their normal achieving peers as seen in their poor recall performance on a noun paired associate memory task and study strategies that they used. When first asked how they tried to remember, at least 60 percent of the good readers in grades 7, 8 and 9 mentioned using metamemory as a strategy, only 30 percent of the reading disabled in grades 7 and 8 demonstrated an awareness of metamemory. The grade 9 reading disabled appeared to be somewhat more aware, with 43 percent stating that visual or verbal elaboration strategies would aid memory, although analysed results showed no significant difference for that group. Since the age range for the three grades overlapped, this perhaps explained why no developmental effect for metamemory across groups was evident in this study.

The following section will discuss each hypothesis:

Hypothesis 1 stated that reading disabled students will recall fewer word pairs compared to the normal achievers. Data analyzed showed that the reading disabled demonstrated poor memory performance. Their mean recall of pairs was 3.7 compared to 8.7 for the normal achievers. This deficit in memory is supported by the literature.

Hyothesis 2 stated that the reading disabled students will demonstrate less awareness of metamemory strategies (visual or verbal elaboration) in recall and studying the word pairs compared to the normal achievers. Data analysis, as presented by Tables 4 and 5 and Figures 1 and 2, indicated that the reading disabled were lacking in their awareness that a memory strategy was required in order to study the word pairs for successful recall.

The fact that the reading disabled groups showed little difference between metamemory knowledge or no metamemory knowledge in recall is a concern, especially when studies (Pressley and Levin, 1977; Rohwer, 1973; Waters, 1983) indicated that metamemorial

development should be well in place by adolescence. Analysis of nonmetamemory strategies indicated that the reading disabled adolescents in this study were still primarily using rehearsal as their memory strategy. Most appeared unaware that the noun paired-associate memory task presented to them required a more effective mnemonic if they were to remember the words for recall. Torgesen (1980) inferred that using rehearsal shows primacy effects. Often the reading disabled subjects recalled only the first, second, or third pair correctly, which tends to support Torgesen's suggestion.

Relatively few normal achievers used visual or verbal elaboration to study the complete list. Those who did use metamemory for all 20 pairs had higher recall scores. Many students started rehearsing the pairs and then realized that the task was too ominous unless they started to elaborate. This change of strategy was evident when the students discussed how they tried to remember the pairs, and their statements concurred with the results of Pressley & Levin (1977). Students who used elaboration mentioned that the more bizarre or amusing the association the easier it was to remember the pair. The author observed a smile or could hear a chuckle from some of the subjects as certain pairs were presented. Many of the associations formed were similar for some of the students, e.g. snowman with a banana for a nose, or a dinosaur and pirate both from the olden days. If a student had difficulty reading a pair and was told the correct pronunciation, this reinforcement also seemed to aid recall. Other strategies reported by a few students were identical to the findings of Pressley and Levin (1977); these were, paying attention to the first letters of the two nouns, or determining if pairs were the same colour.

Pressley (1982) found, from studies on elaboration, large individual differences in the use of the strategy. Rohwer et al. (1982) hypothesized. "that learners differ in their propensity to remove arbitrariness by elaborating meaningful relationships among items to be associated." The present study also found vast differences among individual subjects regardless of IQ or age even in the normal achiever group. Some very good readers performed as poorly as the poor readers. However, only 4 of the 38 reading disabled subjects recalled eight or more pairs, which

was the approximate mean recall for the normal achievers. It was evident that reporting elaboration as a strategy for memory related directly to recall performance, which concurs with Pressley and Levin (1977). The poor readers' lack of awareness and employment of metamemory appeared to directly affect their recall performance. Some reading disabled subjects stated that they had visualized the pairs but with further probing it became evident that each word was visualized individually with no association within each pair. These students recognized that visualization could aid memory but lacked the knowledge that the relationship was critical for associative recall.

Hypothesis 3 stated that the older reading disabled students (grade 9) should use more metamemory as study strategies and therefore have a better recall performance than the younger reading disabled students (grade 7). Table 3 presents the evidence that the grade 9 reading disabled demonstrated the same level of metamemory awareness for study strategies as the normal achieving grade 8. Their response was almost twice that of the reading disabled grades 7 and 8's indicating a definite developmental trend towards awareness of metamemory for this older group. However, recall performance was deficient. Although more reading disabled grade 9 students realized elaboration would help on the paired associate memory task, they did not actively use it to study the words.

There are other factors that may influence the reading disabled adolescent's awareness and use of metamemory skills. Do these students have a production deficiency? Are they "inactive learners?" Do they demonstrate different behaviours than their normal achieving peers? These factors will now be discussed.

Students with a production deficiency can be taught mnemonic aids and show marked improvement in memory performance (Torgesen, 1977; Pressley & Dennis-Rounds, 1980; Wong, 1980; Rose et al., 1983). Solar (1983) instructed learning disabled adolescents to use elaboration. She found a significant difference in recall performance for word pair associates for this group compared to the uninstructed control group. The learning disabled benefitted as much from instruction as the normal achievers but did not perform as well. Sternberg and

Wagner (1982) suggested that "learning disabled children may remain at the stage of consciously directed performance much longer than non-disabled children." Results from the present research suggested that reading disabled adolescents do not generalize remedial instruction they may have had in the elementary grades. Will reading disabled students develop spontaneous metamemorial skills or will they forever have a "production deficiency"? Could this mean that previous remedial instruction was not designed to teach learning disabled students mnemonic strategies? With limited reading skills, these students may have less basic knowledge to draw upon for other learning or memory experiences. At a time in their school careers when more and more accumulated knowledge must be remembered, co-ordinated and tested, these could pose serious problems for academic success.

Does this lack of cognitive awareness and motivation exemplify Torgesen's (1977) description of the "inactive learner"? Gelheiser et al. (1983) suggested that the learning disabled may be relatively unskilled in learning to the point of automaticity. These students may be preoccupied processing basic components such as decoding words, or developing a mnemonic, that they do not recognize the similarities between tasks nor can they focus on analysing task demands. Maier (1980) and Torgesen & Licht (1983) concurred with this theory. This perhaps explains why the learning disabled seem less active, planful and organized in their approach to memory tasks compared to their normally achieving peers (Torgesen & Licht, 1983).

With reading disabled students in this research reading 1 year, 6 months to 6 years below grade level, it is not surprising that they have met with academic failure and thus may have developed negative self-perceptions of their ability (Boersma & Chapman, 1981). The experimenter observed some behavioural differences between the two groups. The poor readers seemed less at ease in the testing situation and many slumped in the chair. The task often seemed more ominous for them and many quickly said "my memory isn't very good." The normal achievers looked at the task as more of a challenge and seemed less concerned if they performed poorly. The reading disabled had greater difficulty expressing the strategies they

used and needed more probing in order for the examiner to have a clear indication of exactly what they did. The reading disabled guessed more often at an answer or filled in a word that seemed appropriate, e.g. ocean-shark, necktie-suit, road-bike, or stared blankly if they didn't know the answer. The good readers would more often say "I don't know". One reading disabled student forgot his scheduled appointment twice, and the third time the secretary had to call him to the office. Another poor reader called his mother to take him home after the memory task, because he "felt sick". Good rapport developed during the session with each student could not overcome the poor self-image that some students had of themselves. Although it appeared that all subjects tried their best, the poor readers may have felt disheartened by another task with which they had to struggle.

A. Implications of the Research

Is there help for the reading disabled adolescent? Wong (1985) stated that learning disabled adolescents may have less specific content knowledge in various subject areas, e.g. history, science, because more effort has been spent working on deficient reading skills. She suggested that, since learning disabled students tend to be "inactive learners", teachers "must spend time mobilizing them to search for relevant background information so as to understand new materials." Gelzheiser et al. (1983) stressed that basic concepts have to be automatized so that central processing can attend to more complex tasks such as mnemonics, monitoring and evaluation.

Deshler et al. (1984) have envisaged a comprehensive intervention model to teach learning disabled adolescents to be independent and active learners. One of the major emphases within this model is teaching the learning disabled "how to learn" with task-specific strategies that they can apply. Instruction would include: 1) providing the rationale, 2) describing the steps of the strategy, 3) modeling of the strategy by the teacher, 4) verbal rehearsal of the steps by the student, 5) practice in applying the strategy with controlled material, 6) practice with content material, and 7) positive and corrective feedback (Alley & Deshler, 1979). Clark et

al. (1984) suggested that, with the learning disabled's limited reading ability, applying the strategy to content material might have to be a gradual process starting at his/her ability level and slowly working up towards grade placement level. Besides teaching exact strategies, methods to instruct learning disabled students when to apply a specific strategy will have to be developed and researched (Brown, 1981; Clark et al., 1984).

Do present remedial programs for learning disabled students work on basic skills rather than a strategy approach to learning? Although basic academic skills are a necessary foundation, by the time a learning disabled student reaches adolescence more comprehensive programming appears to be necessary if s/he is to meet with academic success. Innovative planning as described by Wong (1985), Deshler et al. (1984), Clark et al. (1984), Brown (1981), offers potentially useful instructional techniques. In order to judge if these are a viable answer, committed teachers and researchers interested in comprehensive interventional models will have to be recruited.

Research has shown that learning disabled students with a "production deficiency" in memory strategies can be instructed for improved performance (Solar, 1983; Rose et al., 1983; Wong, 1980). However, for long term gains educators will have to take a hard look at more comprehensive remedial programming for learning disabled adolescents.

B. Recommendations for Future Research

Further research in this area might want to examine more closely whether intelligence relates to a student's ability to be more aware of and actively use metamemorial strategies. IQ could be more carefully controlled. Individual intelligence tests such as the Weschler Intelligence Scale for Children - Revised, rather than group intelligence tests, as used in the present study, would probably define more accurately the subject's intellectual capabilities. This would allow for a better comparison of the reading disabled and normally achieving subjects, when relating intelligence to performance on a memory task.

The researcher should also be aware of the attitudes that a learning disabled student brings to a testing situation. A shorter list of word pairs or a longer time frame might improve application of memory strategies since the subjects might feel less pressured.

Future studies of metamemorial development could focus on a comparison of learning disabled students at the junior high and upper high school levels. Older adolescent learning disabled students may use memory strategies spontaneously and therefore would not be considered developmentally delayed compared to their normally achieving peers.

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VIII. APPENDIX 1

Student No: Name Grade Av/NA Date

Strategies used / Word Pair	Freq	Recall Strategy used: Recall	Read	Reh	Vis	Verb	Comments
ANIMAL - STAR	H						
BANANA - SNOWMAN	L						
BOOKCASE - PUDDLE	L						
CHAIR - MORNING	H						
DINOSAUR - PIRATE	L						
EYEBROW - HOCKEY	L						
FINGER - PICTURE	H						
GRANDFATHER - BEET	L						
ICE - CLUB	H						
LAKE - BUILDING	H						
MONEY - STICK	H						
NECKTIE - BLUEJAY	L						
OCEAN - MACHINE	H						
ROAD - NOTE	H						
ROCKET - BUG	L						
SHARK - BICYCLE	L						
SUIT - ISLAND	H						
VIOLIN - FOOTPRINT	L						
WINDSHIELD - TEAPOT	L						
YARD - MONTH	H						

IX. APPENDIX 2

Table 1

2 x 3 ANOVA: Word Pairs recalled using metamemory, Normal Achievers/Reading Disabled by grades 7, 8, 9

Source	df	Mean Squares	F Ratio	Probability
groups	1	520.237	20.814	0.000
grades	2	16.841	0.674	0.512
groups x grades	2	3.378	0.135	0.874
Error	84	24.994		
Total	89	29.890		

Table 2

2 x 3 ANOVA: Word Pairs recalled using no metamemory, Normal Achievers/Reading Disabled by grades 7, 8, 9

Source	df	Mean Squares	F Ratio	Probability
groups	1	0.673	0.151	0.699
grades	2	2.747	0.615	0.543
groups x grades	2	2.494	0.558	0.574
Error	84	4.467		
Total	89	4.342		

Table 3

2 x 3 ANOVA: Word Pairs studied using metamemory, Normal Achievers/Reading Disabled by grades 7, 8, 9

Source	df	Mean Squares	F Ratio	Probability
groups	1	560.148	13.125	0.001
grades	2	12.439	0.291	0.748
groups x grades	2	51.482	1.206	0.304
Error	84	42.678		
Total	89	48.011		

Table 4

2 x 3 ANOVA: Word Pairs studied using no metamemory, Normal Achievers/Reading Disabled by grades 7, 8, 9

Source	df	Mean Squares	F Ratio	Probability
groups	1	560.152	13.125	0.001
grades	2	12.445	0.292	0.748
groups x grades	2	51.482	1.206	0.304
Error	84	42.678		
Total	89	48.011		

Table 10

2 x 2 ANOVA: Word Pairs recalled, Normal Achievers/Reading Disabled by Meta/No meta

Source	df	Mean Squares	F ratio	Probability
Between groups (A)	1	247.61	22.8261	0.00001
Error	74	10.85		
Within meta/no meta (B)	1	148.03	8.1530	0.00558
A x B	1	168.42	9.2763	0.00322
Error	74	18.16		
Total	76	21.84		

Table 6

2 x 2 ANOVA: Total Word Pairs recalled, Normal Achievers/Reading Disabled by High IQ/Low IQ

Source	df	Mean Squares	F ratio	Probability
groups	1	569.302	25.929	0.000
IQ	1	25.912	0.725	0.397
groups x IQ	1	0.032	0.001	0.970
Error	86	21.956		
Total	89	27.792		

Table 7

2 x 2 ANOVA: Word Pairs recalled using metamemory, Normal Achievers/Reading Disabled by High IQ/Low IQ

Source	df	Mean Squares	F ratio	Probability
groups	1	525.155	21.079	0.000
IQ	1	3.783	0.152	0.698
groups x IQ	1	0.048	0.002	0.965
Error	86	24.914		
Total	89	30.018		

Table 8

2 x 2 ANOVA: Word Pairs recalled using no metamemory, Normal Achievers/Reading Disabled by High IQ/Low IQ

Source	df	Mean Squares	F ratio	Probability
groups	1	0.891	0.200	0.656
IQ	1	4.178	0.936	0.336
groups x IQ	1	0.178	0.040	0.842
Error	86	4.464		
Total	89	4.373		

Table 9

2 x 2 ANOVA: Word Pairs studied using metamemory, Normal Achievers/Reading Disabled by High IQ/Low IQ

Source	df	Mean Squares	F ratio	Probability
groups	1	522.121	12.153	0.001
IQ	1	0.027	0.001	0.980
groups x IQ	1	5.617	0.131	0.719
Error	86	42.964		
Total	89	47.446		

Table 10

2 x 2 ANOVA: Word Pairs studied using no metamemory, Normal Achievers/Reading Disabled by High IQ/Low IQ

Source	df	Mean Squares	F ratio	Probability
groups	1	522.129	12.153	0.001
IQ	1	0.031	0.001	0.979
groups x IQ	1	5.617	0.131	0.719
Error	86	42.964		
Total	89	47.446		

Table 11

2 x 3 ANOVA: Word Pairs studied by reading, Normal Achievers/Reading Disabled by grades 7, 8, 9

Source	df	Mean Squares	F ratio	Probability
Groups	1	0.071	0.003	0.956
Grades	2	34.472	1.467	0.236
Groups x Grade	2	5.015	0.213	0.808
Error	84	23.497		
Total	89	23.065		

Table 12

2 x 3 ANOVA: Word Pairs studied by rehearsal, Normal Achievers/Reading Disabled by grades 7, 8, 9

Source	df	Mean Squares	F ratio	Probability
Groups	1	547.785	10.523	0.002
Grades	2	62.207	1.195	0.308
Groups x Grade	2	24.988	0.480	0.620
Error	84	52.058		
Total	89	57.248		

Table 13

2 x 2 ANOVA: Word Pairs recalled using metamemory, Normal Achievers/Reading Disabled by Availability/Non Availability of Material

Source	df	Mean Squares	F ratio	Probability
groups	1	525.155	22.017	0.000
availability	1	72.875	3.055	0.084
groups/availability	1	11.274	0.473	0.494
Error	86	23.852		
Total	89	29.894		

Table 14

2 x 2 ANOVA: Word Pairs recalled using no metamemory, Normal Achievers/Reading Disabled by Availability/Non Availability of Material

Source	df	Mean Squares	F ratio	Probability
groups	1	0.891	0.202	0.654
availability	1	0.140	0.032	0.859
groups/availability	1	9.473	2.152	0.146
Error	86	4.402		
Total	89	4.372		

Table 15

2 x 2 ANOVA: Word Pairs studied using metamemory, Normal Achievers/Reading Disabled by Availability/Non Availability of Material

Source	df	Mean Squares	F ratio	Probability
groups	1	522.113	12.207	0.001
availability	1	21.957	0.513	0.476
groups/availability	1	-0.004	-0.000	1.000
Error	86	42.771		
Total	89	47.442		

Table 16

2 x 2 ANOVA: Word Pairs studied using no metamemory, Normal Achievers/Reading Disabled by Availability/Non Availability of Material

Source	df	Mean Squares	F ratio	Probability
groups	1	522.133	12.208	0.001
availability	1	21.965	0.514	0.476
groups/availability	1	0.004	0.000	0.092
Error	86	42.771		
Total	89	47.443		

X. APPENDIX 3

Mean Pairs Recalled

	High frequency words (10 pairs)	Low frequency words (10 pairs)
grade 7 normal achievers	2.94 (S.D. = 2.11)	3.88 (S.D. = 2.83)
grade 8 normal achievers	4.39 (S.D. = 2.63)	5.22 (S.D. = 3.15)
grade 9 normal achievers	4.28 (S.D. = 2.88)	5.33 (S.D. = 3.33)
grade 7 reading disabled	1.5 (S.D. = 1.43)	1.5 (S.D. = 1.75)
grade 8 reading disabled	1.79 (S.D. = 1.26)	1.93 (S.D. = 1.87)
grade 9 reading disabled	2.07 (S.D. = 1.62)	2.00 (S.D. = 1.13)